

Atlas of E. Arctic combustion particle records and distributions: A paleoecological perspective on non-CO₂ pollutants and climate

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Nunavut: Eastern Arctic Canada

Figure 1

Sites investigated follow a rough transect from Sanikiluaq on Hudson Bay in the south to Alert at the northern end of Ellesmere Island.



Classification and Atlasing as an approach to documenting distributions...

- 1 scale bar is 40 μm
- 2 scale bar is 40 μm
- 3 scale bar is 40 μm
- 4 scale bar is 40 μm
- 5 scale bar is 40 μm
- 6a scale bar is 20 μm
- 6b scale bar is 40 μm
- 7 scale bar is 40 μm
- 8 scale bar is 40 μm
- 9 scale bar is 100 μm
- 10 scale bar is 50 μm
- 11 scale bar is 50 μm
- 12 scale bar is 35 μm

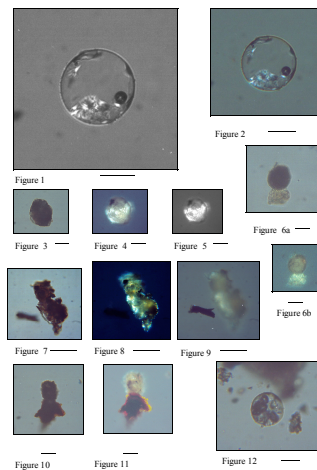


Figure 2a Incinerator Fly
Ashes

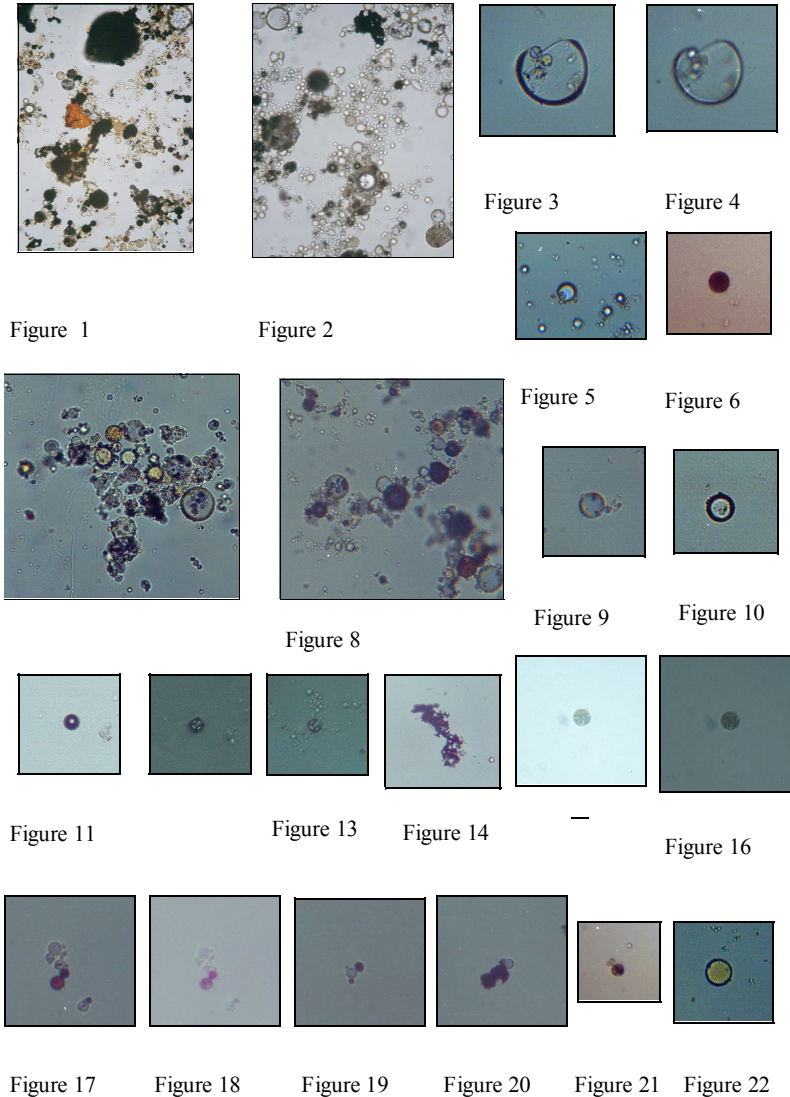


Figure 2b Coal Fly Ashes

Figure 3: Environmental particles

Plate 9 Hawk Lake and Belcher Islands

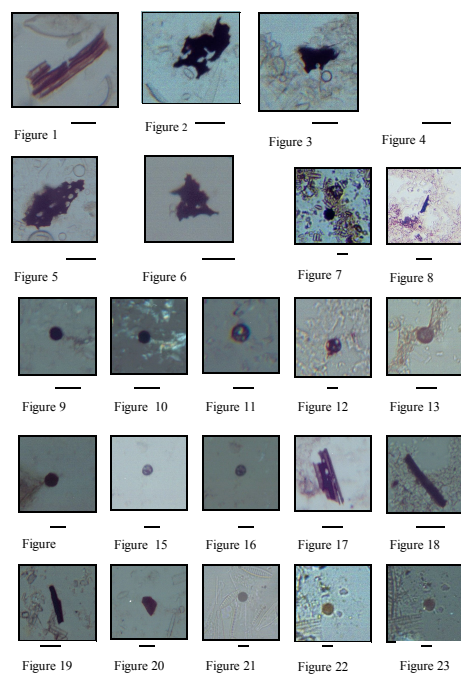


Plate 11 Spheroidal - multiple locations

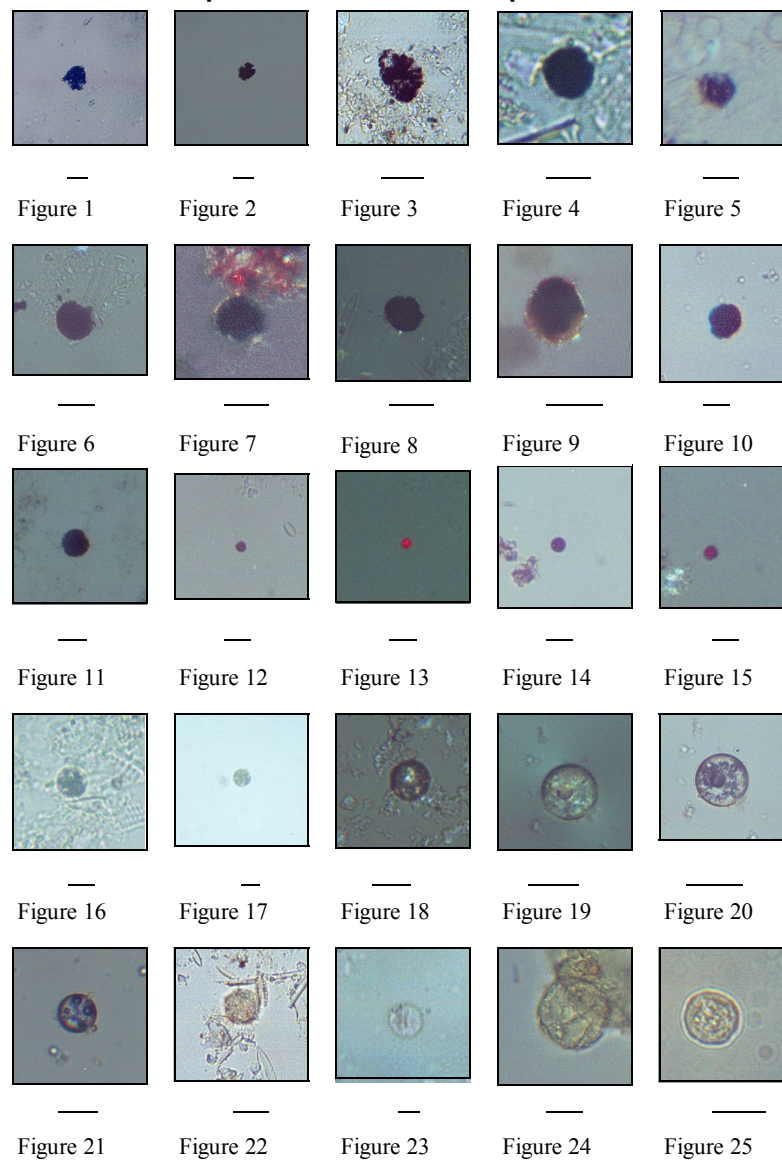


Figure 4: Environmental combustion particles from Alert, Cape Herschel, and Keewatin

PLATE 11 Alert and Cape Herschel, Ellesmere Island

Kirk Lake Figure 1 – 5

Horseshoe Pond Figure 6 – 17

Hawk Lake Figure 18 – 25

Figure 1 980213 charcoal lath scale bar is 50 μm

Figure 2 scale bar is 50 μm

Figure 3 scale bar is 50 μm

Figure 4 scale bar is 20 μm

Figure 5 scale bar is 10 μm

Figure 6 scale bar is 10 μm

Figure 7 scale bar is 10 μm

Figure 8 scale bar is 20 μm

Figure 9 scale bar is 10 μm

Figure 10 (same particle as in 9) scale bar is 10 μm

Figure 11 scale bar is 10 μm

Figure 12 scale bar is 25 μm

Figure 13 scale bar is 15 μm

Figure 14 scale bar is 15 μm

Figure 15 scale bar is 15 μm

Figure 16 scale bar is 15 μm

Figure 17 scale bar is 15 μm

Figure 18 scale bar is 3 μm

Figure 19 scale bar is 10 μm

Figure 20 scale bar is 5 μm

Figure 21 scale bar is 20 μm

Figure 22 scale bar is 20 μm

Figure 23 scale bar is 5 μm

Figure 24 scale bar is 10 μm

Figure 25 scale bar is 10 μm

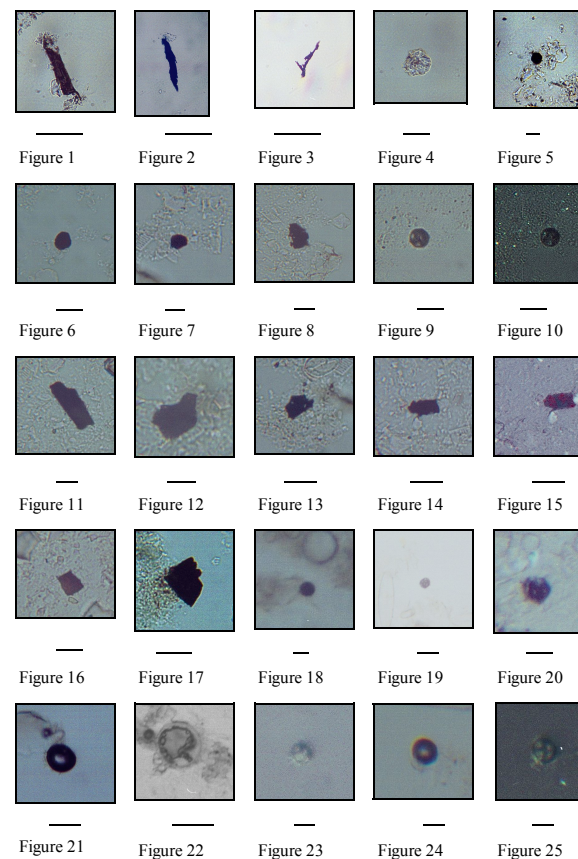


Figure 5: Functional Classification of Combustion Particles

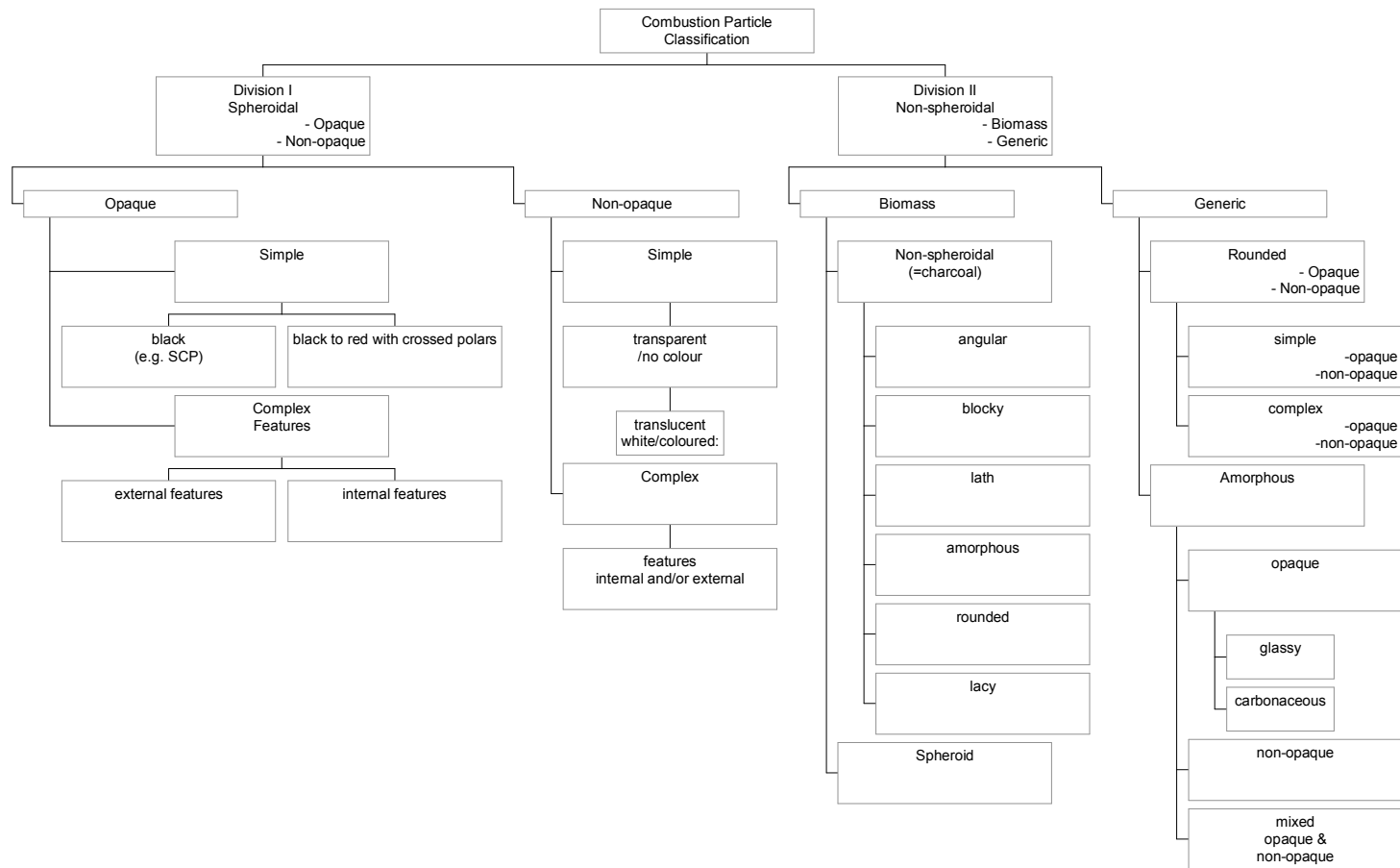


FIGURE 6: Hawk Lake, Keewatin. **(a)** Histogram showing distribution of all combustion particles enumerated in the core, as a percentage, by particle type. **(b)** Histogram showing distribution of all combustion particles in core with depth as percentage of the total particles enumerated.

(a) Key

SPCBK – spheroidal, carbonaceous,
black type

Csph – cenosphere type

SPNBK – spheroidal, non-black type

Psph – pleurosphere type

chtot – total charcoal of all types

cmgen – combustion generic (black) type

cmamop – combustion, amorphous
opaque type

cmanop – combustion angular opaque
type

cmRN – combustion rounded opaque
type

cmmix – combustion mixed opaque-
nonopaque type

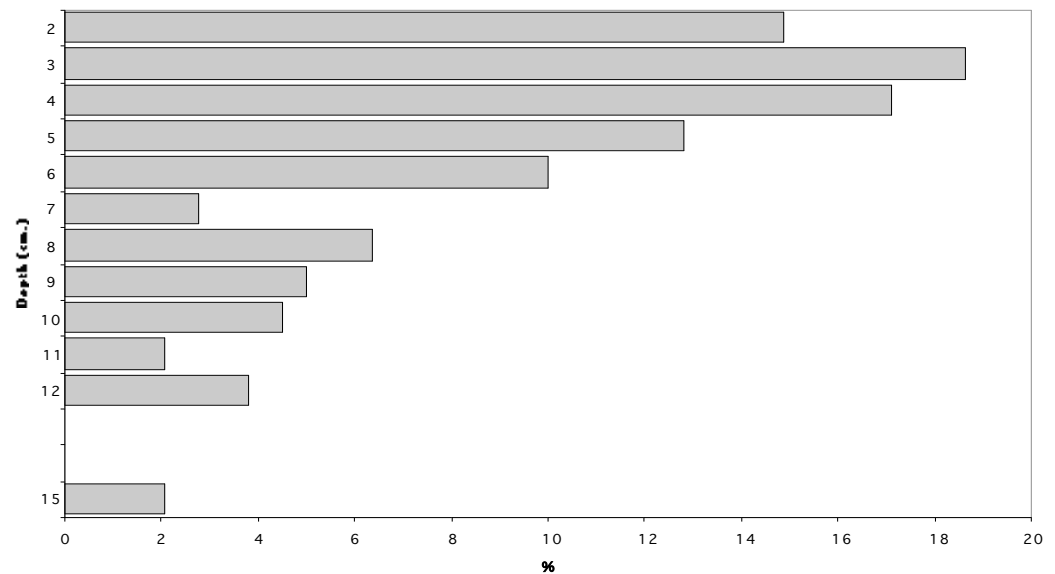
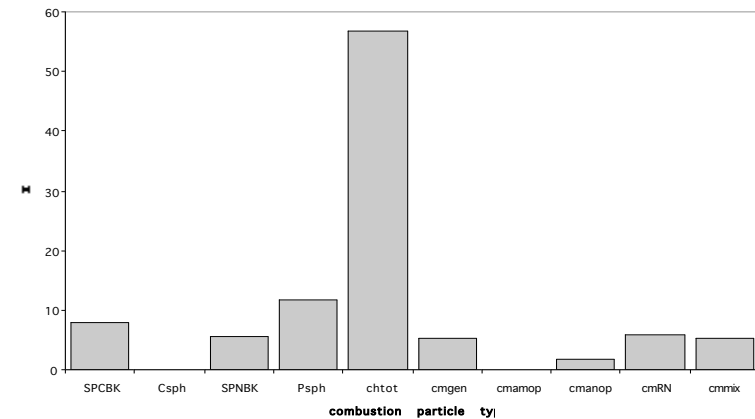


FIGURE 7. Hawk Lake, Keewatin. **(a)** Distribution of spheroidal, carbonaceous, black type particles (SPCBK) in the core with depth (cm.), as a percentage of total combustion particles enumerated. **(b)** Distribution of charcoal particles in the Hawk Lake core with depth (cm.) as percentage of total combustion particles enumerated.

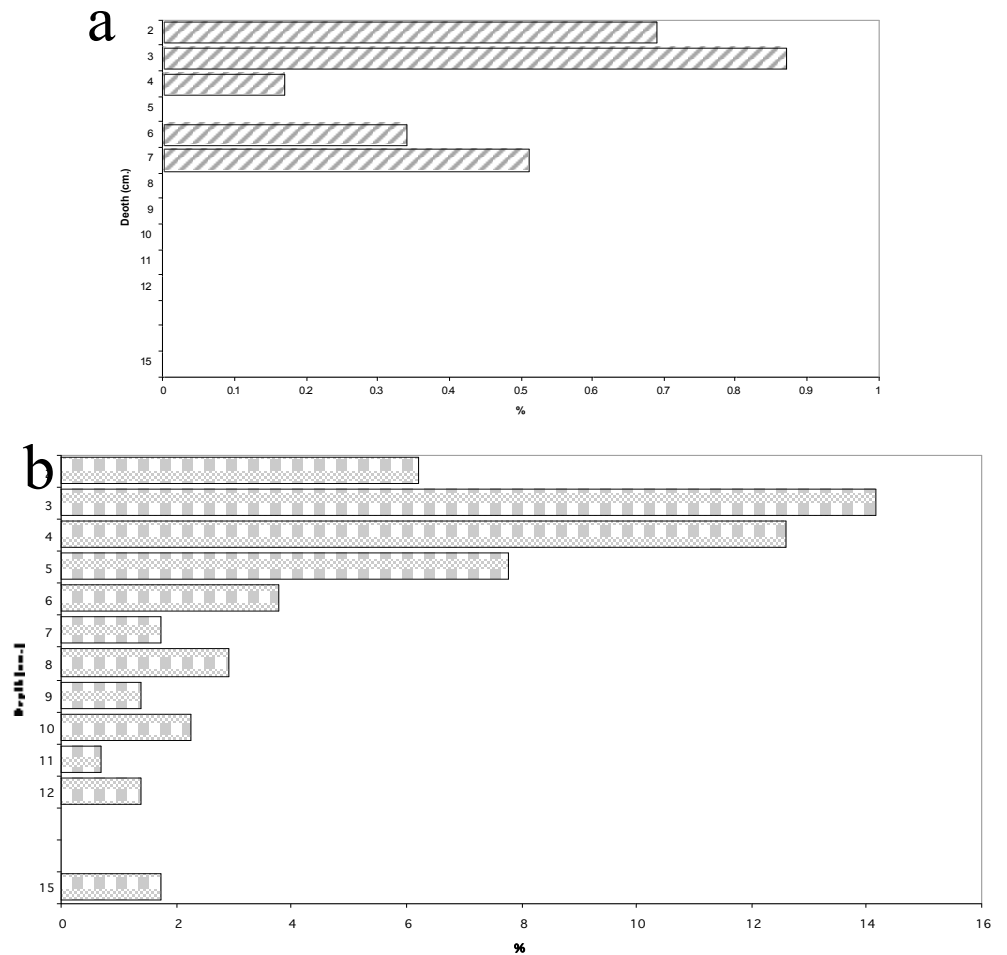


FIGURE 8. Horseshoe Pond, Cape Herschel, Ellesmere Island, Nunavut. **(a)** Histogram showing relative abundance of combustion particles of all types, as percentage of the total combustion particles enumerated in the sediment samples selected for analysis, with depth (cm.) in the core. **(b)** Histogram showing the relative abundance of combustion particles shown in (a) but with combined categories for charcoal (chtot), and for amorphous combustion (cmtot).

FIGURE 2 **(a)** Key

SPCBK – spheroidal, carbonaceous, black type

Csph – cenosphere type

SPNBK – spheroidal, non-black type

Psph – pleurosphere type

chtot – total charcoal of all types

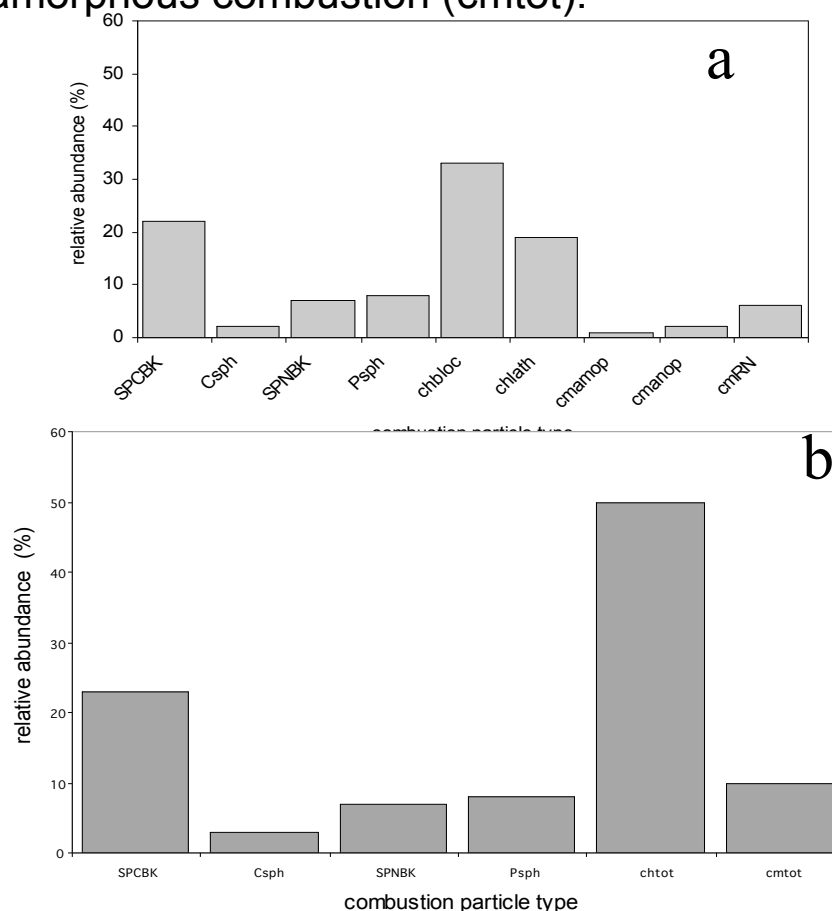
cmtot – combustion total, including:

cmgen - generic (black) type

cmanop – combustion angular opaque type

cmRN – combustion rounded opaque type

cmmix – combustion mixed opaque nonopaque type



1991

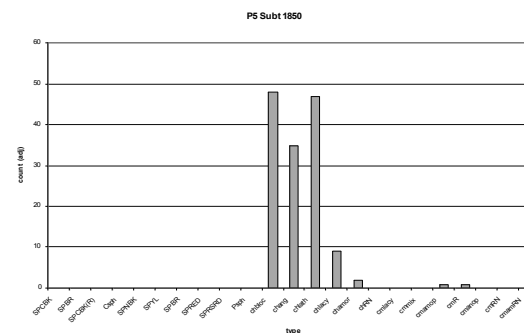
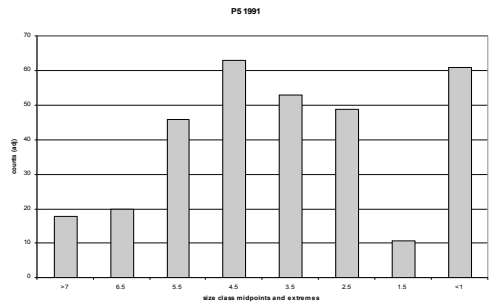
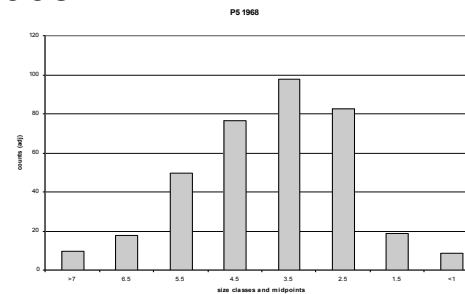


Figure 10: Changes in the combustion record through time: Pond 5, Belcher Is., Changes in size range (SR) (here we are comparing surface to depth, down core) at 1991, 1968, 1944, and 1850. (Note: size classes are presented largest to smallest.)

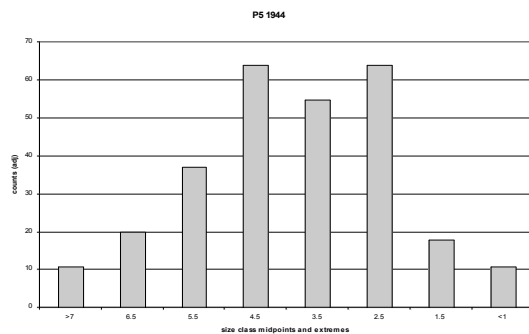
1991



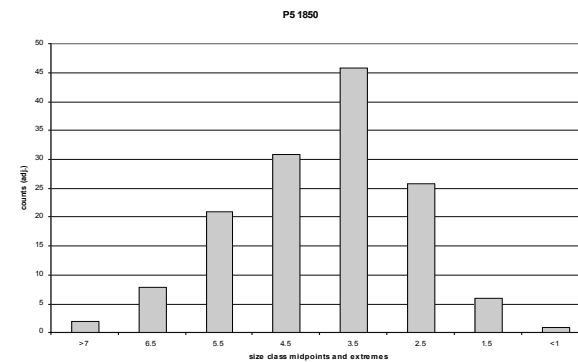
1968



1944



1850



Relevance

and

Limitations

- Addresses black carbon component.
- Means of distinguishing changing nature of inputs to environment through time.
- Physical link to source regions (back trajectories).
- Size distributions coupled with type assist in separating local, regional and long-range signals.
- Useful potentially where physical evidence of link between source and sink is desirable.

- Classification is time-consuming, and microscopy is labour-intensive.
- The range of particle sizes addressed is orders of magnitude larger in (some cases) than those of interest to the atmospheric science community.
- Limits to detection for high quality optical work make using these methods effectively a challenge.